(12) UK Patent Application (19) GB (11) 2 099 529 A

(21) Application No 8116889
(22) Date of filing 2 Jun 1981
(43) Application published 8 Dec 1982
(51) INT CL³ F16L 21/00
(52) Domestic classification F2G 20 24E2
(56) Documents cited None
(58) Field of search F2G
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(54) **Improvements in and relating to pipe connectors**

(57) The present invention relates to a pipe connector particularly but not exclusively for use in connecting pipe sections of a pipe string for use in drilling.

The pipe connector comprises a pin member (1) having a generally frusto-conical outer peripheral surface (5) and a box member (3) having a corresponding generally frusto-conical inner peripheral surface (6), the members being in use telescoped together with the peripheral surfaces overlying one another. Intermediate end surface portions (17 to 20), the peripheral surfaces (5, 6) are provided with annular grooves (7) and projections (10) which are interengageable to axially lock the members together. The crests of the projections and roots of the grooves lie on generally frusto-conical surfaces having the same conicity as the frusto-conical surfaces of the peripheral surfaces, and the end surface portions (17, 18) of the box member lie intermediate the frusto-conical surfaces of the roots of the grooves and the peripheral surface thereof or on the frusto-conical surface of the peripheral surface thereof, and the end surface portions (19, 20) of the pin member lie intermediate the frusto-conical surfaces of the peripheral surface and the crests of the projections or on the frusto-conical surface of the crests of the projections. The end surface portions are thus relatively dimensioned to be a force fit one on the other to create stressed bands at the ends of the overlapped surfaces of the members and to minimise the extent to which these surfaces of the box member have to expand or of the pin member have to contract to disengage the members.

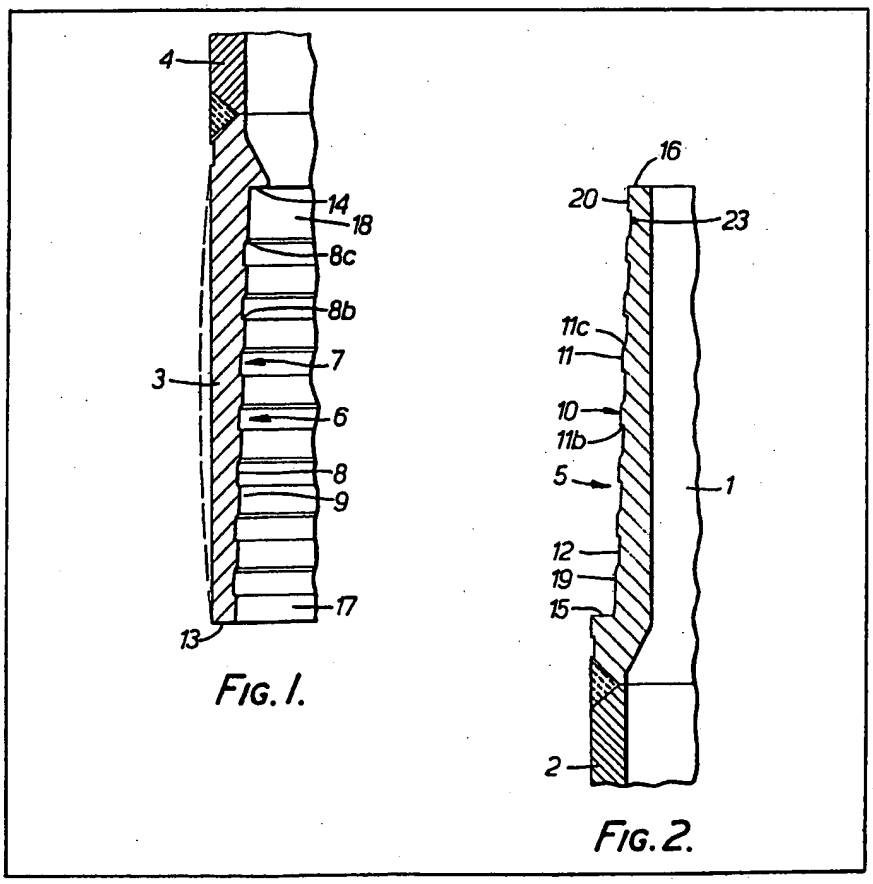

FIG. 1.

FIG. 2.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

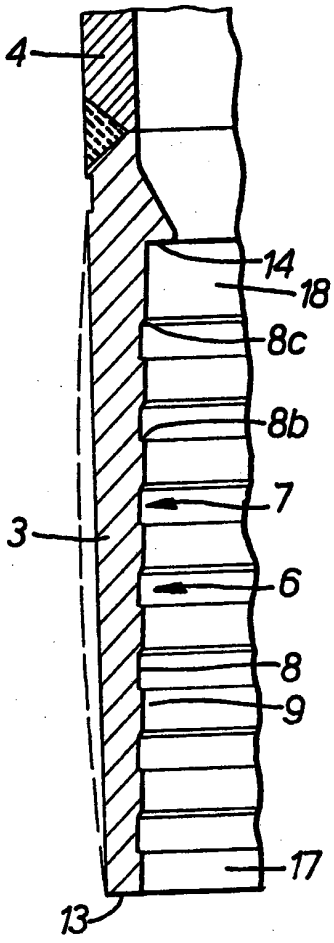

FIG. 1.

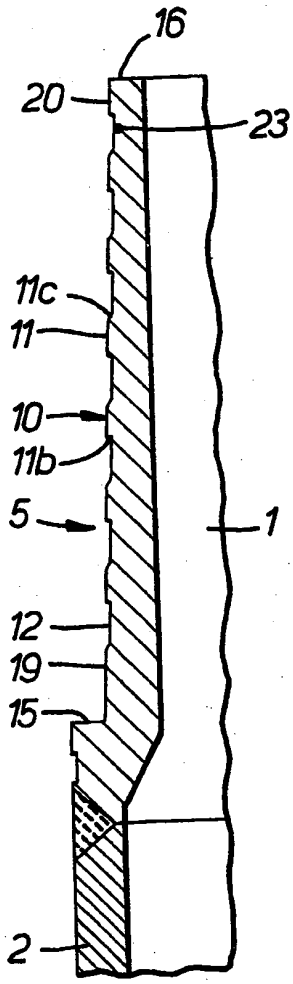

FIG. 2.

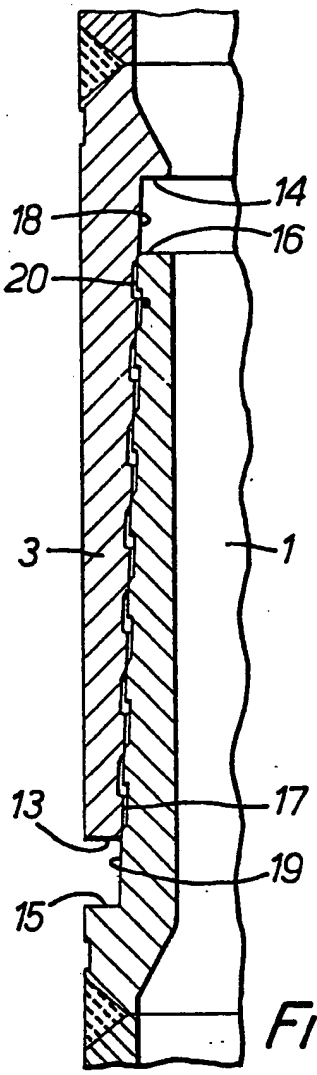

FIG. 3.

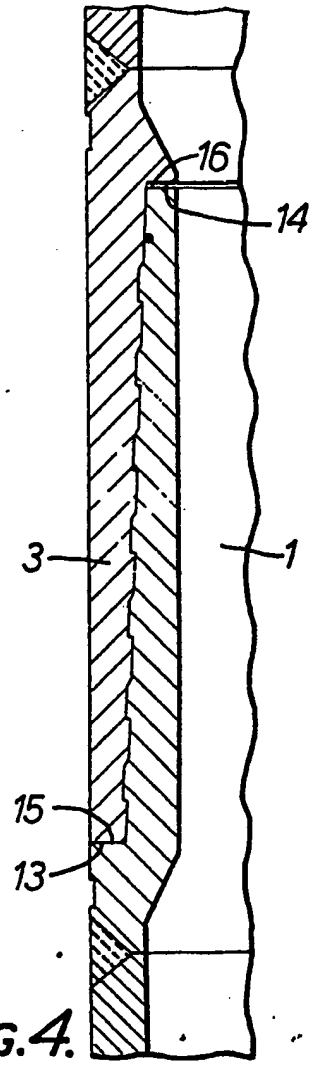

FIG. 4.

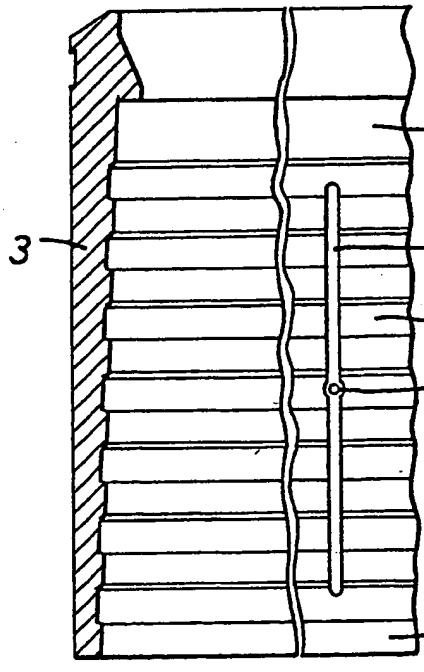

FIG. 5.

SPECIFICATION

Improvements in and relating to pipe connectors

The present invention relates to pipe connectors particularly but not exclusively for use in connecting pipe sections of a pipe string for use in drilling. More particularly the invention relates to an improvement in the pipe connectors described in British Patent Specification No. 1573945, and copending application No. 7844120.

In Specification No. 1573945 there is described a pipe connector comprising a tubular pin member having a frusto-conical outer peripheral surface and a tubular box member having a frusto-conical inner peripheral surface corresponding to the frusto-conical outer peripheral surface of the pin member. In use, the two members are telescoped together and are axially locked together by interengageable annular projections and grooves provided on the said peripheral surfaces, the projections and grooves being spaced apart along and extending the full length of, the two surfaces.

In telescoping the two members together, the members are initially telescoped until surface contact is made between at least portions at the ends of the overlapped portions of the members to provide seals. Then fluid under pressure is preferably supplied between the members to expand the box member and/or contract the pin member while at the same time an axial force is applied to the members to bring them together. To disengage the members, fluid under pressure is again supplied between the members to expand the box member and/or contract the pin member to progressively bring the projections out of the grooves and so permit the members to be moved axially apart. However, for the pressurised fluid to be effective, seals must be maintained at both ends of the overlapped frusto-conical surfaces. It has been found that if there is any tendency in either of the two members to deviate from the circular during this expansion/contraction, the resulting ovality of the member will effectively break the seal so that the pressure of the fluid is dissipated and the members cannot then be disengaged.

According to the present invention, it is proposed that this problem be obviated by arranging the two members so that no substantial expansion/contraction of the members is required at the two ends of the overlapped frusto-conical surfaces. To this end each member is provided at each end of the frusto-conical surface with an annular surface portion which lies on a frusto-conical surface which is preferably the frusto-conical surface defined by the crests of the projections or surfaces between the grooves or at least lies intermediate the radially spaced frusto-conical surfaces defining the crests of the projections and surfaces between the projections or root surfaces of the grooves and surfaces between the grooves. This then reduces the extent to which the box member must be expanded and/or the pin member must be contracted to disengage the two members and therefore reduces the effect of any tendency of either of the two members to deviate from the circular.

The frusto-conical surfaces of the two members are dimensioned and arranged so that the end surface portions of the members can be brought into sealing contact before fluid under pressure is applied to the connector to assist in fully engaging the members. Thus when disengaging the members, the seals at the ends of the frusto-conical surfaces of the members only have to be maintained while the members are moved apart at most by the axial extents of these surfaces.

In the pipe connector described in British Patent Specification No. 1573945 the cones defining the various frusto-conical surfaces have straight line generatrices. To ensure that, when the members according to the present invention are fully engaged, the frusto-conical surfaces have straight line generatrices, one or both of the members may be made with the corresponding generatrices slightly convex, in respect of the box member, and concave, in respect of the pin member, when in a relaxed condition.

The invention will be more fully understood from the following description, given by way of example only with reference to the accompanying drawings, in which:

Figures 1 and 2 are axial sections through the box member and pin member respectively of an embodiment of a pipe connector in accordance with the present invention;

Figure 3 is an axial section through the pin and box members of Figures 1 and 2 during assembly;

Figure 4 is an axial section through the pin and box members of Figures 1 and 2 when assembled; and

Figure 5 is an axial section similar to that of Figure 1.

As shown in the drawings, the pipe connector comprises a tubular pin member 1 for connection, e.g. by welding, to the end of a pipe 2, and a tubular box member 3 for connection, e.g. by welding, to the end of a pipe 4 to be connected to pipe 2. The pin and box members are telescopingly engageable and have generally corresponding generally frusto-conical outer and innter peripheral surfaces 5, 6 respectively which overlie one another when the pin member 1 is fully inserted into the box member 2.

To axially lock this pin member relative to the box member when the members are engaged, the box member has in its frusto-conical surface 6 a plurality of circumferentially extending annular grooves 7, each groove extending in a radial plane, having a root surface 8 parallel to surface 6, radially extending end surfaces 8*b*, 8*c*, and being spaced by a surface 9 from the adjacent groove. It will be appreciated that the surfaces 9 form the surface 6. The root surfaces 8*a* lie on a generally frusto-conical surface having the same conicity as surface 6.

The pin member has axially spaced

circumferentially extending annular projections 10 corresponding to the grooves 7 and having planar crest surfaces 11 parallel to surface 5, radially extending end surfaces 11*b*, 11*c*, and being spaced by a surface 12 from the adjacent projections, it will be appreciated that surfaces 12 form the surface 5. The crest surfaces 11 also lie on a generally frusto-conical surface having the same conicity as surface 5.

The grooves 7 and projections 11 are relatively dimensioned and shaped to facilitate assembly of the pin and box members, to resist axial force tending to pull the members apart and to provide surfaces for transmitting axial forces from pipe 2 to pipe 4 and vice versa.

The box member has at each end of its frusto-conical surface 6 radial surfaces 13, 14 and the pin member has corresponding radial surfaces 15, 16. If the connector is to be used under circumstances where axial forces are to be transmitted between the members, for example where a pipe string is to be used for pile driving, the members are arranged so that radially extending surfaces 8*b*, 11*b* of the grooves and projections are in contact and are held in contact by abutment between one of the pair of end surfaces 13, 15 and 14, 16. As shown surfaces 13, 15 are in abutment when the members are fully engaged. Preferably the members are arranged so that they have a shrink fit one in relation to the other to maintain the surfaces 13, 15 and 8*b*, 11*b* in contact.

The projections and grooves 7, 10 do not extend the full length of the frusto-conical surfaces of the members and at the ends of the frusto-conical surfaces of the members, surface portions 17, 18 for the box member and 19, 20 for the pin member are provided. As shown these end surface portions lie on the frusto-conical surfaces defined by the crests of the projections on the pin member and surfaces between the grooves on the box member respectively. In effect and by comparison with the pipe connector described in Specification No. 1573945, the grooves at the inner ends of the pin and box members respectively have been omitted.

The projections and grooves and surface portions 17 to 20 are relatively dimensioned so that the pairs of surfaces 15, 17 and 18, 20 are a force-fit one on the other and will create stressed bands at each end of the overlapped surfaces of the members. Preferably, as described in Specification No. 1573945, the projections and grooves are relatively dimensioned so that, when the members are fully engaged, there are slight clearances between surfaces 8, 11, 9, 12 and 8*c*, 11*c*.

The box member is, as shown in Figure 5, provided with a radial passage 21 which communicates with an axially extending recess 22 in the frusto-conical surface 6 and which intercepts the grooves 7. The passage 21 is adapted for connection to a source of fluid, e.g. a liquid such as oil, under pressure, for example at a pressure of about 5000 to 7000 psi for pin and box members made of high tensile steel.

The connector is designed to be assembled as follows. Initially the pin member 1 is pushed into the box member 3 until contact is obtained between surfaces 17 and 19 and 18 and 20, as shown in Figure 3. Liquid under pressure is then applied to the radial passage 21 and flows via recess 22 through out the length of overlap of the frusto-conical surfaces of the members between the contacting surfaces at the two ends. Simultaneously an axial force is applied to the members, for example using the calliper type jack described in Specification No. 1573945. The level of pressure of the liquid applied to the passage 21 is arranged so that it will cause the box member to expand and/or pin member to contract sufficient to enable the two members to be pushed fully together. The contact between the pairs of surfaces 17, 19 and 18, 20 is, during this period, effectively lost because the liquid forms a hydrostatic bearing. However, the consequent leakage of liquid is not sufficient to cause an effective reduction in the pressure of liquid applied to the surfaces.

When the members of the connector have been fully engaged, the liquid supply to passage 21 is disconnected and liquid can then be drained through passage 21 from the connector. In use, the outlet of passage 21 may be sealed to prevent ingress of dirt.

It will be appreciated that when the fluid pressure between the frusto-conical surfaces of the members is relieved when the members are fully engaged, the members 1, 3 will relax so that the projections and grooves are engaged. Engagement will be full intermediate the ends of the frusto-conical surfaces but immediately adjacent the end portion surfaces 17 to 20 the projections will not engage fully in the grooves because of the relative dimensioning of these surfaces, which, as previously mentioned, create stressed band which are a force-fit one on the other. As previously mentioned, when the members are fully engaged, end surfaces 13, 15 are in abutment as are radially extending surfaces 8*b*, 11*b*. Clearances are provided between surfaces 8, 10 and 9, 12 and 8*c*, 11*c* (as shown in Figure 5 of Specification No. 1573945).

To disengage the members pressurised fluid is again applied to passage 21 and flows the full length of the overlapped surfaces of the members between surfaces 17 and 20. The members 1, 3 are progressively contracted and/or expanded respectively to disengage the projections from the grooves, the contacting surfaces 17 to 20 provide seals. Finally the members are expanded just sufficient to provide clearance between surfaces 17, 19 and 18, 20 for hydrostatic bearings to be established. Simultaneously with the application of fluid under pressure, an axial force is provided tending to move the members apart and, as soon as the hydrostatic bearing has been established, the members will move apart. As soon as the members have reached the relative positioning shown in Figure 3 the supply of fluid under

pressure can be discontinued because the members are then, in their relaxed conditions, freely movable away from each other. It will be appreciated that with this arrangement, because expansion and/or contraction of the box and pin members in the regions of the surfaces 17 to 20 is very slight, there is no risk of the seal provided by these surfaces being destroyed by any tendency of either member to deviate from the circular.

It will be appreciated that in the foregoing, any contraction of the pin member and expansion of the box member is arranged so that the elastic limit of the material of the members is not exceeded.

In the connector described above and shown in Figures 1 to 3, the pin and box members have frusto-conical surfaces 5, 6 defined by straight line generatrices when in their relaxed states. Because of the relative dimensioning of the end portions 17 to 20, when the two members are engaged, although the engaged frusto-conical surfaces will also have approximately straight line generatrices, the corresponding outer peripheral surface of the box member and/or inner peripheral surface of the pin member will have a slightly concave, in respect of the box member, and convex, in respect of the pin member, generatrix. It may be found desirable to ensure that both these surfaces have straight line generatrices when the members are engaged. To effect this the inner and outer peripheral surfaces of the box member and/or the pin member may be provided with slightly convex, in respect of the box member, and concave, in respect of the pin member, generatrices, as shown by the broken lines in Figures 1 and 2.

An O-ring seal 23 may be provided in the end surface 12 at the free end of the pin member.

If the connector is to be able to transmit torque, the force-fit between surfaces 17 and 20 may be relied on. However, should separate torque transmission means be required, an inwardly projecting pin may be provided at the inner end of the frusto-conical surface of the box member for engagement in a recess provided in the leading edge of the pin member.

In a preferred embodiment, the pin and box members are made of high tensile steel and have external and internal diameters respectively of about 70 cm (28 inches). The conicity of the frusto-conical surfaces is 2°, each tooth has a height of about 0.12 cm (0.048 inches) and each groove has a depth of about 0.11 cm (0.044 inches). The end face 8*b* of each groove and the corresponding face 11*b* of each projection has a taper of 12° to a plane perpendicular to the axis of the pin and box members and the face 8*c* of each groove and the corresponding face 11*c* of each projection has a taper of 60°.

In the above described connector the projections and grooves are arranged so that in the condition shown in Figure 3 not only is there contact between surfaces 17, 19 and 18, 20 but there is also contact between the crest surfaces of the projections and surfaces between the grooves. Additionally the projections merely have to slide over these surfaces between the grooves to engage in their respective grooves. With this arrangement it may not be necessary to apply fluid pressure to the surfaces to engage the two members, although a higher axial force will be required than if fluid pressure is applied. However other relative axial dimensioning of the projections and grooves may be provided whereby there is no contact between crest surfaces of projections and of the surfaces between the grooves when the members are initially brought into contact and indeed the projections and grooves may have a greater or lesser axial length than those shown in the drawings, relative to the length of the surfaces 17, 19 and 18, 20 and relative to the axial movement required after the members have been brought into initial metal-to-metal contact.

While as described in the foregoing, the surfaces 17 to 20 lie on the frusto-conical surfaces defined by surfaces 9 and 11 of the grooves and projections, it may be that the degree of force-fit between these surfaces can be relieved by dimensioning them to lie on frusto-conical surfaces between those defined by surfaces 8 and 9 of the box member and 11 and 12 of the pin member.

It will be further appreciated that while the above described connector has been described in terms of projections provided on the pin member and grooves provided in the box member, this is exactly equivalent to the provision of grooves in the pin member and projections in the box member.

There is thus provided a pipe connector which has a simple construction, is easy to assemble, is mechanically locked when the two members are interengaged, and is easy to disassemble.

While the projections and grooves of the connector of this application have been described in terms of the connector of specification No. 1573945, the formation and arrangement of the projections and grooves may alternately be as described in copending Patent Application No. 7844120.

CLAIMS

1. A pipe-connector comprising a tubular pin member having a generally frusto-conical outer peripheral surface and a tubular box member having a generally frusto-conical inner peripheral surface corresponding generally to the frusto-conical outer peripheral surface of the pin member, the members being in use telescoped together with the inner peripheral surface of the box member overlying the outer peripheral surface of the pin member, the peripheral surfaces of the pin and box members respectively being provided intermediate end surface portions thereof with axially spaced annular interengageable projections and grooves which when interengaged hold the members together axially, wherein the crests of the projections and roots of the grooves lie on generally frusto-conical surfaces having the same conicity as the frusto-conical surfaces of the peripheral surfaces thereof, both of the end

surface portions of the pin member lie on frusto-conical surfaces which are spaced radially outwardly from the frusto-conical surface of the peripheral surface thereof, and both of the end surface portions of the box member lie on frusto-conical surfaces which are spaced radially inwardly from the frusto-conical surface of the roots of the grooves therein.

2. A pipe connector as claimed in Claim 1, wherein the end surface portions of the members are relatively dimensioned to be a force fit when fully overlapped to create stressed bands at the ends of the overlapped surfaces of the members.

3. A pipe connector as claimed in either Claim 1 or Claim 2, wherein the peripheral surfaces of the members and the projections and grooves therein are relatively dimensioned so that the members will telescope together without the application of any substantial force to bring the end surface portions thereof into contact.

4. A pipe connector as claimed in any one of the preceding claims, wherein the frusto-conical surfaces of the end surface portions of the pin member lie on the frusto-conical surface of the crests of the projections therein.

5. A pipe connector as claimed in any one of Claims 1 to 3, wherein the frusto-conical surfaces of the end surface portions of the pin member lie intermediate the frusto-conical surfaces of the peripheral surface thereof and of the crests of the projections thereof.

6. A pipe connector as claimed in any one of the preceding claims, wherein the frusto-conical surfaces of the end surface portions of the box member lie on the frusto-conical surface of the peripheral surface thereof.

7. A pipe connector as claimed in any one of Claims 1 to 5, wherein the frusto-conical surfaces of the end surface portions of the box member lie intermediate the frusto-conical surfaces of the roots of the grooves therein and of the peripheral surface thereof.

8. A pipe connector as claimed in any one of the preceding claims, wherein the generatrices defining the cones of the frusto-conical surfaces of the box member are convex when the box member is in a relaxed condition such that when fully engaged with the pin member, the generatrices will be straight lines.

9. A pipe connector as claimed in any one of the preceding claims, wherein the generatrices of the frusto-conical surfaces of the pin member are when the pin member is in a relaxed condition concave such that when the pin member is fully engaged with the box member the generatrices will become straight lines.

10. A pipe connector as claimed in any one of the preceding claims, wherein the projections and grooves are relatively dimensioned so that, when the pin and box members are fully engaged together, clearance will be provided between the roots of the grooves and the crests of the projections.

11. A pipe connector as claimed in any one of the preceding claims, wherein an opening is provided in the wall of the box member for connection to a source of fluid under pressure, the opening communicating with an axial groove in the peripheral surface thereof intersecting the annular grooves provided therein to permit fluid to flow throughout the extent of the peripheral surfaces intermediate the end surface portions of the pin and box members.

12. A pipe connector as claimed in any one of the preceding claims, wherein the free end surface of one of the members is arranged to abut a surface provided on a shoulder on the other member when the members are fully engaged, the surfaces being held in abutment by abutment between corresponding radially extending surfaces of the projections and grooves.

13. A pipe connector as claimed in any one of the preceding claims made of metal, wherein metal-to-metal seals are provided by the peripheral end surface portions of the members.

14. A pipe connector substantially as herein described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.